METHOD OF ASSEMBLING EXTREME PRESSURE BELTED STRUCTURES

This is a division of application Ser. No. 06/682,569 filed Dec. 14, 1984, now U.S. Pat. No. 4,582,243, in turn a continuation of application Ser. No. 06/302,891 filed Sept. 16, 1981, now abandoned, in turn a division of application Ser. No. 06/137,092 filed Apr. 4, 1980, now U.S. Pat. No. 4,308,044 which was patented Dec. 29, 1981.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to high pressure vessels and a method for their assembly.

2. Description of the Prior Art and Background Considerations

The fabrication of containers for extreme pressures was originated and developed by P. W. Bridgeman where concentric prestressed belts of high strength alloys are assembled about a container wall to place the innermost layer thereof under compression. Conventionally, pre-stressing is achieved by heating and expanding the outer belts with respect to the inner layers of the container. Upon assembly and cooling, the belts contract upon the inner layers. Such thermal expansion is limited to small dimensional changes, and does not easily generate large dimensional changes, e.g., approximately one percent. In addition, even if sufficient expansion were obtainable by thermal means, the required high temperatures would change the mechanical properties of the components. Therefore, it has been necessary to look to other means by which the necessary pre-stress can be obtained.

In the fabrication of certain types of optical fibers, extrusion at high pressure is employed. The cylinder surrounding the extrusion piston used in this application must be of great strength and be capable of containing the very high pressures developed during extrusion. In the present invention, sintered carbides, such as tungsten or titanium, were found suitable for the extrusion cylinder. These materials have the necessary strength and have no chemical or physical effect on the extruded fiber. However, these high strength materials are also brittle and have a tendency to crack under tension. Therefore, it is necessary to fashion the sintered carbide as a tubular insert and to enclose it under great compressive pre-stress within a sleeve of hardened tool or tempered alloy steel so that, even during the application of the high extrusion pressures therein, there would still be some remaining compressive force exerted upon the carbide insert. To assemble the insert in the sleeve for the reasons described above, thermal expansion and contraction was insufficient to generate the required large dimensional changes of about one percent. Also, as stated above, any heating necessary to obtain a thermal expansion would destroy the temper of the components.

Therefore, the titanium carbide die was inserted into the hardened tool steel sleeve first by concentrically tapering the mating surfaces of the insert and the sleeve with a slight oversizing of the insert with respect to the sleeve, and then by axially compressing the insert into the sleeve. Such a method of assembly, however, gave rise to a dual, contradictory problem in that low friction durihg assembly, and high friction after assembly for retention of the insert within the sleeve were required.

For example, a titanium carbide insert lubricated with a high pressure lubricant and retained in a sleeve, was expelled with explosive force after release of the assembly pressure, even though the taper angle of the mating surfaces was only 1.2°. Yet, if no lubricant were used, the assembly process would have caused galling, resulting in a scored interface between the insert and the sleeve with unknown and undesired mechanical properties.

SUMMARY OF THE INVENTION

Resolution of these and other problems was obtained by the present invention by providing lubrication of the tapered surfaces during assembly, and locking of the assembly after its completion by mechanical and metallurgical techniques.

Mechanically, mateable grooves are formed in the cooperating tapered surfaces of the insert in the sleeve. In the preferred embodiment, a radially compressible ring is installed in the external cylinder insert groove. During axial compression with lubrication, the ring does not project above the adjacent surface but is squeezed into its groove until total insertion is completed. As soon as the tapered insert reaches its desired penetration within the sleeve, the ring expands and snaps into the juxtaposed groove and firmly and permanently locks the assembly together.

Alternately, a radially expandable ring may be retained in the internal groove of the sleeve; however, in this case, a special pilot pin must be inserted into the sleeve to permit expansion of the ring, and assembly of the insert.

Metallurgical locking is obtained by coating the insert and/or the sleeve with a metal which is capable of lubricating the interface during assembly and which will subsequently diffuse into the surrounding metals of the insert and the sleeve to lock them together. Typical metals include gold, copper, silver, nickel and aluminum.

It is, therefore, an object of the present invention to provide for a low friction assembly and permanent bond of concentric taper belted high pressure containers.

Another object of the present invention is to provide for assembly of ultra-high pressure vessels without use of thermal expansion techniques.

Other aims and objects as well as a more complete understanding of the present invention will appear from the following explanation of exemplary embodiments and the accompanying drawings thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** depicts a first embodiment of the present invention illustrating a mechanical locking technique, with the taper of, and the spacing between, component parts being greatly exaggerated;

FIG. **2** is an enlarged view of a mechanical interlocking of FIG. **1**; and

FIG. **3** illustrates the metallurgical technique of interlocking the components, again shown with great exaggeration of the taper of and spacing between the parts.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIGS. **1** and **2**, an assembly **10**, useful, for example, in extrusion of optical fibers, comprises a cylinder or insert **12** held and locked within a sleeve **14**. The cylinder is provided with a bore **16** through which the fiber materials are pushed for extrusion. Exemplary